

THE EFFECT OF WATERING REGIMES AND BIO AND CHEMICAL TREATMENTS ON FLOWERING OF *EUPHORBIA MILII* VAR. *LONGIFOLIA* PLANTS

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ABSTRACT: This study was carried out in the nursery of Ornamental Plants and Landscape Gardening Research Department, Horticulture Research Institute, Agriculture Research Centre, Giza, Egypt in two successive seasons (2015/2016 and 2016/2017) to study the effect of soil drench with some bio- and chemical materials (moringa extract, potassium silicate, salicylic acid and ascorbic acid) combined with different water intervals (1, 2, 3 and 4 weeks) on vegetative growth, flowering and chemical composition of *Euphorbia milii* var. *longifolia* transplants grown in 25 cm plastic pots. Results could be briefed in the following: watering at 2 weeks seems to be more effective in increasing the values of most studied characters. On the other hand, both moringa extract and ascorbic acid resulted in the highest values of studied characters. Regarding combination between irrigation intervals and different bio- and chemical materials, all untreated control plants irrespective of their watering regime, in addition to plants watered at 4 weeks interval and treated with either moringa extract or potassium silicate, did not flower at all over the period of this study. Meantime, the same plants recorded the lowest values of many characters irrespective of the watering regime. Plants treated with moringa extract and watered at 1 week interval had the highest values of flower diameter, number of branches, root length and root fresh weight. Those watered at 2 weeks interval achieved the highest rank of number of leaves and flowers, flower diameter, fresh and dry weight of flowers, P%, K% and total chlorophyll content. Plants treated with ascorbic acid combined with irrigation at 2 weeks interval got the highest records of plant height, stem length, leaf length, fresh weight of leaves, stem fresh and dry weights, total chlorophyll and carotenoids content. In conclusion it is recommended to irrigate *Euphorbia milii* var. *longifolia* grown in 25 cm plastic pots at 2 weeks interval, combined with treating plants with either moringa extract or ascorbic acid in order to get the best results.

Key words: *Euphorbia milii* var. *longifolia*, irrigation intervals, moringa extract, potassium silicate, salicylic acid, ascorbic acid.

INTRODUCTION

Euphorbia milii Des Moul. (crown of thorns, Christ plant, Christ thorn) is

a species of flowering plant in the spurge family Euphorbiaceae, native to Madagascar. It is a succulent climbing shrub growing to 1.8 m tall, with densely

spiny stems. It is much esteemed for its brilliant flower-like inflorescences. However, it is a slow-growing limited-branching plant. These insufficiencies affect its use in different aspects of landscaping as bed, pot or hedge plant and even for indoor decoration (InterNet Site 1, 2017). In order to overcome this problem different irrigation regimes and some treatments were tried. These treatments include moringa extract, potassium silicate, salicylic acid and ascorbic acid.

As we face the threat of reduction in our quota the Nile River water, we are obliged to modulate irrigation methods to decrease water loss. Water is an important factor in the growth, development and productivity of plants. Hartmann *et al.* (2005) reported that water stress due to drought is the most significant abiotic factor limiting plant growth and development. Emmanuel (2014) stated that water is a major constituent of all living organisms which is involved in important biochemical processes including photosynthesis. Thus, its availability in adequate quantity and at biologically tolerable interval affects productivity of plant species.

Asres (1995), Anwar and Bhangar (2003), Bennett *et al.* (2003) and Emongor (2012) claimed that the moringa leaf contains proteins, minerals, vitamins, essential amino acids, glucosinolates, isothiocyanates and phenolics. Andrews (2006) and Price (2007) mentioned that the active growth enhancing substances in *Moringa* leaf extract are zeatin, dihydrozeatin and isopentyladenine which are natural (endogenous) cytokinins. Price (2007) stated that extracts from fresh *Moringa* leaves could be used as an effective plant growth enhancer. Fuglie (2000 a, b) reported that application of moringa extract increased maize growth. Both the same author and El-Awady (2003) stated that fresh *Moringa oleifera* leaves have been shown to have zeatin, a cytokinin related hormone. Moringa leaves sampled from various parts of the world were found to have high zeatin

concentrations of 5-200 µg/g of leaves. Emongor (2015) observed that the use of *Moringa* leaf extract as a possible plant growth enhancer can provide a relatively environmentally safe, easily accessible and affordable means of increasing crop yields to meet the increasing demand of food.

Voogt and Sonneveld (2001) revealed that depending on the water source, irrigation water may contain trace amounts of Si. Datnoff *et al.* (2007) mentioned that Si may have beneficial effects to plants, alleviating biotic and abiotic stresses in crops like barley, cucumber, oat, rice, rye, sugarcane and wheat. Cavins *et al.* (2010) stated that silicon (Si) is a non-essential nutrient for most plants. However, in field crops it is known to affect plant growth and quality, photosynthesis, transpiration and enhance plant resistance to stresses such as drought. In floriculture production, most plants are grown in soilless substrates consisting primarily of peat moss or pine bark. In these substrates the silicon concentration is limited and its supplementation might be beneficial. Mattson and Leatherwood (2010) claimed that silicon (Si) has an active role in plant physiology. It is a beneficial nutrient that improves biotic and abiotic stress tolerance of several crop species. Vicente and Plasencia (2011) reported that salicylic acid (SA) is an endogenous signal mediating local and systemic plant defence responses against pathogens. SA plays a role during the plant response to abiotic stresses such as drought, chilling, heavy metal toxicity, heat, and osmotic stress. SA plays a crucial role in the regulation of physiological and biochemical processes during the entire lifespan of the plant.

Liu *et al.* (1997) ascertained that ascorbic acid affects nutritional cycle's activity in higher plants and plays an important role in the electron transport system. Noctor and Foyer (1998) and Smirnoff and Wheeler (2000) claimed that ascorbic acid influence mitosis and cell growth in plants. De Tullio *et al.* (1999) and

Arrigoni and De Tullio (2000) stated that L-ascorbic acid serves as a co-factor for many enzymes. Explained that ascorbic acid is important as a cofactor for a large number of key enzymes in plants. Smirnov and Wheeler (2000); Arrigoni and De Tullio (2002); Pignocchi and Foyer (2003) and Gest *et al.* (2013) stated that ascorbic acid may contribute to maintaining photosynthesis, cell-cycle progression, cell wall expansion, gene expression, synthesis of many hormones, anthocyanin and flavonoids. El-Kobisy *et al.* (2005) claimed that ascorbic acid affects plant growth and development, and plays a role in the electron transport system. Reda *et al.* 2005 and Abd El-Aziz *et al.* (2009) stated that vitamins, such as ascorbic acid, could be considered as bio-regulator compounds which, in relatively low concentrations, exert profound influence on plant growth regulating factors that influence many physiological processes, such as synthesis of enzymes. They also act as co-enzymes and affects plant growth. Barth *et al.* (2006) reported that ascorbic acid serves as an important co-factor for the synthesis of some hormones, such as salicylic acid, ethylene and abscisic acid. Ascorbic acid affects phytohormone-mediated signaling processes during the transition from the vegetative to the reproductive phase as well as the final stage of development and senescence.

MATERIALS AND METHODS

This study was carried out at the nursery of the Ornamental Plant Research Department, Horticulture Research Institute, Giza, Egypt in two seasons, 2015-2016 and 2016-2017. The second season was an exact repetition of the first one. On 1st Sept. 2015 rooted cuttings of *Euphorbia milii* var. *longifolia* were used in this study were potted in 25 cm plastic pots filled with about 2 kg of a mixture of sand and peat moss at 1:1 (v:v).

A factorial experiment was laid out in a randomized block design in order to study the effect of two factors on growth and flowering of *Euphorbia milii* var. *longifolia*.

The first factor was some treatments comprising soil drench with a solution of one of the following: moringa extract, potassium silicate (K_2O_3Si), salicylic acid and ascorbic acid, the fifth treatment was plain water (as control treatment). In a scheduled times these additives were dissolved in the irrigation water, which was applied every 1, 2, 3 or 4 weeks, representing the second factor.

Amount of water used each time was equal to the field capacity, or more correctly, pot capacity, which was determined empirically as follows: three 25 cm pots filled with about 2 kg of the potting mixture were watered thoroughly to saturation and weighed. Pots were covered with aluminum foil to prevent evaporation before they were left in a cool shaded place to drain freely for 4 hours. They were weighed again to calculate weight of water held by the potting mixture. Mean of the three pots representing the field capacity was found to be 750 g, equivalent to 750 cm³ of water/pot.

Thus, 750 cm³ of water were given to each pot in due time according to the irrigation schedule. Apart from the first time of irrigation, when all treatments were irrigated together, the second time when this congregational watering occurred was in the twelfth week. This means that at the end of 12 weeks, plants watered at 1, 2, 3 and 4 weeks interval were given 9, 6, 3 and 2.25 liters of water, respectively.

However, this allocation was kept for spring (March, April and May) and autumn (September, October and November). In winter (December, January and February), one third of this amount (250 cm³) was deducted, to be given back in summer (June, July and August) to the same treatments in mid interval to make for the high summer temperature.

Preparation of solutions:

Moringa extract was made using a blender for homogenizing 25 g of young leaves with 100 ml of water. Cheese cloth was used for filtration. The filtrate was used

directly according to treatments. Water solution of potassium silicate was prepared at 500 mg/l. Water solutions of both salicylic acid at 5 mg/l and ascorbic acid at 100 mg/l were prepared. When applied, 750 ml of each substance was prepared and applied to each pot to serve as irrigation and treatment application simultaneously.

The experimental procedures started in September 2015. One year later, *i.e.* September 2016 data were recorded for: plant height (cm), stem length (cm), number of leaves, leaf length (cm), leaf width (cm), number of flowering clusters, number of flowers, flower diameter (cm), number of branches, root length (cm), stem fresh and dry weights (g), leaves fresh and dry weights (g), flowers fresh and dry weights (g) and roots fresh and dry weights (g).

Samples of leaves from the three replicates of each treatment were mixed together and determinations of total carbohydrate content (mg/g d.w.) were carried out according to Herbert *et al.* (1971); total chlorophyll and carotenoids (mg/g f.w.) according to Saric *et al.* (1976); percentages of nitrogen, phosphorus, and potassium according to Jackson (1973), in the Central Lab of the Horticulture Research Institute.

Data were statistically analyzed using analysis of variance as described by Snedecor and Cochran (1989) and means were compared by Duncan critical range at 5% (Duncan, 1955) by means of SAS 1995 computer program.

RESULTS

1. Effect of irrigation intervals, treatments and their interaction on plant height, number of branches and stem characters (Table, 1):

a. Plant height (cm):

The effect of irrigation intervals on plant height was significant in both seasons. The tallest plants were those irrigated every 2 weeks, in addition to those watered every 1

week in the first season or every 3 weeks in the second one.

The shortest plants were those irrigated every 4 weeks, in addition to those supplied with water every 3 weeks in the first season or every 1 week in the second one.

The effect of treatments on plant height was significant in both seasons. The tallest plants were a result of treating plants with ascorbic acid. The second position was occupied by treatments of potassium silicate and salicylic acid; in addition to the moringa extract treatment in the second season only. The shortest plants were those treated with moringa extract in the first season, in addition to the untreated (control) plants, in the first and second seasons.

The effect of the interaction between irrigation intervals and treatments on plant height was significant in both seasons. The tallest plants were those treated with ascorbic acid and irrigated at either 2 or 3 weeks intervals, in addition to those treated with ascorbic acid and irrigated at either 1 or 4 weeks intervals; and those treated with moringa extract and irrigated at 4 weeks interval, in the second season. The shortest plants resulted when plants received no treatments (the control plants) and were watered at 4 weeks interval.

b. Number of branches:

The effect of irrigation intervals on number of branches was significant in both seasons. Watering plants at 1, 2 or 3 weeks intervals gave rise to higher number of branches compared to watering at 4 weeks interval.

The effect of treatments on number of branches was significant in both seasons. Applying moringa extract, K_2O_3Si , salicylic and ascorbic acids resulted in higher number of branches compared to the untreated control plants.

The effect of the interaction between irrigation intervals and treatments on number of branches was significant in both seasons. The highest number of branches belonged to

Table 1. Effect of irrigation intervals, bio and chemical treatments and their interaction on plant height, number of branches and stem characters of *Euphorbia milii* var. *longifolia*.

Treat.	First season					Second season				
	Irrigation intervals (weeks)					Irrigation intervals (weeks)				
	1	2	3	4	Mean	1	2	3	4	Mean
Plant height (cm)										
Control	30.67 f-h	32.03 d-g	26.83 hi	24.50 i	33.23 b-f	29.03 e-g	29.33 d-g	23.27 h	23.27 h	28.72 C
Moringa	26.93 hi	28.73 g-i	29.33 f-h	29.77 f-h	28.63 fg	33.23 b-f	34.23 bc	35.50 a-c	35.50 a-c	32.90 B
K ₂ O ₃ Si	32.67 c-g	33.13 c-f	31.23 e-g	30.47 f-h	28.30 g	34.50 bc	33.83 b-d	33.70 b-e	33.70 b-e	32.58 B
Salicylic	33.30 c-f	35.30 b-e	30.50 f-h	30.30 f-h	34.17 bc	33.80 b-d	30.90 c-g	31.17 c-g	31.17 c-g	32.51 B
Ascorbic	36.03 a-d	39.73 a	37.73 ab	36.83 a-c	34.60 bc	39.53 a	37.10 ab	33.17 b-f	33.17 b-f	36.10 A
Mean	31.92	33.79 A\	31.13 B\	30.37 B\		31.79 B	34.02 A\	33.08 AB	31.36 B	
Number of branches										
Control	0.00 e	0.00 e	0.67 de	1.00 de	0.42 B	0.00 e	0.33 e	0.33 e	0.00 e	0.17 B
Moringa	6.00 a	4.33 a-c	3.33 a-d	1.33 c-e	3.75 A	6.67 a	4.00 a-c	3.00 b-e	0.67 de	3.58 A
K ₂ O ₃ Si	2.33 b-e	2.67 b-e	5.00 ab	0.00 e	2.50 A	2.33 b-e	3.00 b-e	2.67 b-e	1.00 c-e	2.25 A
Salicylic	3.00 a-e	4.33 a-c	2.67 b-e	0.00 e	2.50 A	4.33 ab	3.00 b-e	2.33 b-e	0.00 e	2.42 A
Ascorbic	1.67 c-e	5.33 ab	4.33 a-c	0.67 de	3.00 A	3.67 a-d	2.67 b-e	2.00 b-e	0.00 e	2.08 A
Mean	2.60 A\	3.33 A\	3.20 A\	0.60 B\		3.40 A\	2.60 A\	2.07 A\	0.33 B\	
Stem length (cm)										
Control	20.17 b-f	18.77 b-f	16.43 ef	15.47 f	17.71 B	18.53 c-f	20.43 a-e	16.87 d-f	14.27 f	17.52 C
Moringa	18.13 c-f	19.27 b-f	27.88 a	18.17 c-f	20.86 AB	20.30 b-e	22.67 a-c	22.50 a-c	18.67 c-f	21.03 AB
K ₂ O ₃ Si	19.68 b-f	21.73 a-f	21.00 b-f	19.80 b-f	20.55 AB	21.91 a-d	22.90 a-c	19.00 c-f	16.13 ef	19.99 BC
Salicylic	22.30 a-e	23.57 a-d	20.83 b-f	17.37 d-f	21.02 AB	20.83 a-e	20.73 a-e	20.50 a-e	17.87 c-f	19.98 BC
Ascorbic	21.40 a-f	25.27 ab	24.23 a-c	24.17 a-c	23.77 A	25.40 ab	25.63 a	23.17 a-c	18.41 c-f	23.15 A
Mean	20.34 AB\	21.72 AB\	22.08 A\	18.99 B\		21.40 A\	22.47 A\	20.41 A\	17.07 B\	
Stem fresh weight (g)										
Control	37.46 gh	38.53 f-h	28.32 h	27.81 h	33.03 C	43.46 d-h	34.14 g-i	29.97 hi	21.21 i	32.20 B
Moringa	44.33 d-g	46.10 d-g	49.35 c-g	42.59 e-h	45.59 B	38.84 e-i	55.07 b-e	61.93 a-d	55.68 a-e	52.88 A
K ₂ O ₃ Si	54.85 b-d	54.45 b-d	48.94 c-g	46.29 d-g	51.13 B	61.90 a-d	66.78 a-c	53.43 b-f	33.22 g-i	53.83 A
Salicylic	57.07 b-e	58.69 b-d	53.05 b-f	37.53 gh	51.59 B	61.23 a-d	54.61 b-e	50.77 c-g	35.34 f-i	50.49 A
Ascorbic	61.70 bc	77.11 a	66.04 ab	57.12 b-e	65.49 A	70.78 ab	74.50 a	59.72 a-d	33.42 g-i	59.61 A
Mean	51.08 A\	54.98 A\	49.14 A\	42.27 B\		55.24 A\	57.02 A\	51.16 A\	35.77 B\	
Stem dry weight (g)										
Control	2.24 fg	2.39 e-g	1.77 g	1.73 g	2.03 C	1.98 gh	2.09 f-h	1.87 gh	1.75 h	1.92 B
Moringa	3.20 c-g	3.61 b-g	4.24 a-e	2.58 e-g	3.41 B	3.76 a-e	4.07 a-e	4.12 a-e	3.41 c-g	3.84 A
K ₂ O ₃ Si	3.99 a-f	5.11 ab	3.54 b-g	2.73 d-g	3.84 AB	4.09 a-e	5.30 a	3.26 d-h	2.52 e-h	3.79 A
Salicylic	4.67 a-c	4.84 a-c	3.46 b-g	2.45 e-g	3.86 AB	4.06 a-e	4.15 a-d	3.60 b-f	2.00 gh	3.45 A
Ascorbic	5.35 ab	5.51 a	4.53 a-d	3.61 b-g	4.75 A	4.96 a-c	5.17 ab	3.95 a-e	2.71 d-h	4.20 A
Mean	3.89 A\	4.29 A\	3.51 A\	2.62 B\		3.77 AB\	4.16 A\	3.36 B\	2.48 C\	

Means with the same letter are not significantly different at 5% level according to Duncan.

plants watered at 1 week interval and treated with moringa extract. The lowest record in the same question (here no branches were produced at all) was observed on untreated control plants watered at 1, 2 weeks interval in the first season or at 1 or 4 weeks interval in the second one; in addition to plants watered at 4 weeks interval and treated with K_2O_3Si or salicylic acid in the first season; or with salicylic or ascorbic acids in the second one.

c. Stem length (cm):

The effect of irrigation intervals on stem length was significant in both seasons. Watering plants at 1, 2 or 3 weeks intervals gave rise to taller stems compared to 4 weeks interval.

The effect of treatments on plant height was significant in both seasons. The tallest stems were a result of applying ascorbic acid or moringa extract, in addition to K_2O_3Si or salicylic acid. The shortest stems were the untreated control plants in the first and second seasons.

3.2.c. Effect of the interaction between irrigation intervals and treatments:

The effect of the interaction between irrigation intervals and treatments on plant height was significant in both seasons. The tallest plants were those watered at 2 weeks interval and treated with ascorbic acid, in addition to those watered at 3 weeks and treated with moringa extract in the first season; or irrigated at 1 week interval and treated with ascorbic acid in the second one.

d. Stem fresh weight (g):

The effect of irrigation intervals on stem fresh weight was significant in both seasons. Plants watered at 1, 2 and 3 weeks interval got higher stem fresh weight than those watered at 4 weeks interval.

The effect of treatments on stem fresh weight was significant in both seasons. The heaviest fresh roots were produced by plants treated with ascorbic acid, in addition to those treated with moringa extract, K_2O_3Si and salicylic acid in the second season. The

lightest fresh roots resulted when plants were left with no treatments at all, i.e. the control plants.

The effect of the interaction between irrigation intervals and treatments on stem fresh weight was significant in both seasons. The highest values in this respect were a result of treating plants with ascorbic acid and watering them at 2 or 3 weeks interval, or at 1 or 2 weeks interval. The lowest records were induced by the untreated control plants watered at 4 weeks interval.

e. Stem dry weight (g):

The effect of irrigation intervals on stem dry weight was significant in both seasons. The heaviest dry stems belonged to plants watered at 1, 2 or 3 weeks interval in the first season; and at 1 or 2 weeks interval in the second one. Irrigating plants at 4 weeks interval resulted in the lightest dry stems.

The effect of treatments on stem dry weight was significant in both seasons. Applying K_2O_3Si , salicylic acid and ascorbic acid gave rise to the highest records in this question, besides using moringa extract in the second season. The lightest dry stems were produced by the untreated control plants.

The effect of the interaction between irrigation intervals and treatments on stem dry weight was significant in both seasons. The heaviest dry stems were produced when plants were watered at 2 weeks intervals and treated with K_2O_3Si ; in addition to plants treated with ascorbic acid and watered at 1 or 2 weeks interval in the first season or at 2 weeks intervals in the second one. The lowest records in the same regard belonged to the untreated control plants watered at 3 or 4 weeks in the first season or at 4 weeks interval in the second season.

2. Effect of irrigation intervals, treatments and their interaction on leaves characters (Table, 2):

a. Number of leaves:

The effect of irrigation intervals on number of leaves was significant in both

Table 2. Effect of irrigation intervals, bio and chemical treatments and their interaction on leaves characters of *Euphorbia milii* var. *longifolia*.

Treat.	First season					Second season				
	Irrigation intervals (weeks)					Irrigation intervals (weeks)				
	1	2	3	4	Mean	1	2	3	4	Mean
Number of leaves										
Control	16.33 e	21.00 c-e	19.00 de	19.00 de	18.83 C	20.00 e-g	24.67 b-g	17.00 g	17.67 fg	19.83 B
Moringa	32.67 ab	34.67 ab	26.33 a-e	23.33 b-e	29.25 AB	35.33 a-c	40.67 a	32.67 a-e	23.00 c-g	32.92 A
K ₂ O ₃ Si	29.00 a-d	33.33 ab	24.00 b-e	19.00 de	26.33 AB	30.67 a-f	34.00 a-d	26.00 b-g	22.00 d-g	28.17 A
Salicylic	31.67 a-c	24.33 b-e	24.67 b-e	19.00 de	24.92 B	35.67 a-c	26.67 b-g	25.67 b-g	18.67 fg	26.67 A
Ascorbic	31.00 a-c	33.33 ab	37.00 a	23.67 b-e	31.25 A	37.33 ab	30.33 a-f	27.33 b-g	21.00 d-g	29.00 A
Mean	28.13 A [\]	29.33 A [\]	26.20 A [\]	20.80 B [\]		31.80 A [\]	31.27	25.73	20.47 C [\]	
Leaf length (cm)										
Control	17.23 b-d	17.67 b-d	15.10 d	15.03d	16.26 C	17.83 c-e	16.57 ef	16.67 ef	13.93 g	16.25 C
Moringa	15.33 cd	16.80 b-d	17.50 b-d	17.53 b-d	16.79 BC	18.30 cd	18.23 cd	18.70 b-d	16.07 f	17.83 B
K ₂ O ₃ Si	18.07 b-d	18.33 b-d	17.80 b-d	17.83 b-d	18.01 BC	18.97 bc	18.80 b-d	17.50 c-f	15.97 f	17.81 B
Salicylic	19.00 b	17.80 b-d	18.47 b-d	18.70 bc	18.49 AB	18.67 b-d	18.63 b-d	17.97 c-e	16.57 ef	17.96 B
Ascorbic	19.23 b	23.00 a	19.40 b	19.40 b	20.26 A	18.07 c-e	20.67 a	20.00 ab	17.40 d-f	19.03 A
Mean	17.77 A [\]	18.72 A [\]	17.65 A [\]	17.70 A [\]		18.37 A [\]	18.58 A [\]	18.17 A [\]	15.99 B [\]	
Leaf width (cm)										
Control	4.90 e-g	5.13 d-g	4.57 fg	4.43 g	4.76 B	5.17 c-f	4.80 e-g	4.60 fg	4.17 g	4.68 C
Moringa	5.43 c-f	5.50 c-f	5.63 b-e	5.83 a-e	5.60 A	5.77 a-d	5.83 a-d	5.90 ac	5.60 b-d	5.78 AB
K ₂ O ₃ Si	6.17 a-c	6.73 a	5.87 a-e	5.17 d-g	5.98 A	6.07 ab	5.70 a-d	5.57 bd	5.13 df	5.62 AB
Salicylic	5.97 a-d	6.53 ab	5.67 b-e	5.53 c-e	5.93 A	5.60 b-d	5.87 a-d	5.40 b-e	5.30 c-f	5.54 B
Ascorbic	6.10 a-d	6.40 a-c	5.80 a-e	5.67 b-e	5.99 A	6.13 ab	6.40 a	5.83 a-d	5.40 b-e	5.94 A
Mean	5.71 AB [\]	6.06 A [\]	5.51 B [\]	5.33 B [\]		5.75 A [\]	5.72 A [\]	5.46 A [\]	5.12 B [\]	
Leaves fresh weight (g)										
Control	30.72 e-g	36.48 c-g	23.86 g	23.09 g	28.54 D	40.09 b-f	31.42 e-h	24.29 gh	18.11 h	28.48 D
Moringa	26.32 fg	30.69 e-g	34.33 d-g	39.58 b-f	32.73 CD	44.28 b-e	49.29 a-c	48.74 a-c	36.33 c-g	44.66 AB
K ₂ O ₃ Si	40.76 b-f	40.08 b-f	38.08 b-g	36.25c-g	38.79 BC	41.74 b-e	45.24 b-d	42.30 b-e	19.11 h	37.10 C
Salicylic	50.63 a-c	45.46 a-e	33.95 d-g	32.82 e-g	40.72 B	46.82 a-c	44.90 b-d	33.42 d-g	28.05 f-h	38.30 BC
Ascorbic	45.04 a-e	56.79 a	53.02 ab	47.98 a-d	50.71 A	52.62 ab	58.65 a	46.72 a-d	41.31 b-f	49.82 A
Mean	38.69 A [\]	41.90 A [\]	36.65 A [\]	35.94 A [\]		45.11 A [\]	45.90 A [\]	39.09 B [\]	28.58 C [\]	
Leaves dry weight (g)										
Control	3.11 fg	3.78 e-g	2.79 g	2.83 g	3.13 D	3.02 ef	3.33 d-f	3.24 d-f	2.54 f	3.03 D
Moringa	4.13 d-g	4.30 b-g	4.24 c-g	3.96 d-g	4.16 C	4.99 ab	5.07 ab	4.82 a-c	4.12 b-e	4.75 AB
K ₂ O ₃ Si	4.77 b-g	4.60 b-g	3.92 d-g	3.69 e-g	4.25 BC	4.99 ab	4.57 a-d	3.39 c-f	3.08 ef	4.01 C
Salicylic	6.16 a-c	6.97 a	3.86 e-g	3.93 d-g	5.23 AB	5.16 ab	5.04 ab	3.46 c-f	3.19 d-f	4.21 BC
Ascorbic	5.18 a-e	6.28 ab	5.87 a-d	4.83 b-f	5.54 A	5.53 ab	5.68 a	5.03 ab	4.49 a-e	5.18 A
Mean	4.67 AB [\]	5.19 A [\]	4.14 B [\]	3.85 B [\]		4.74 A [\]	4.74 A [\]	3.99 B [\]	3.48 B [\]	

Means with the same letter are not significantly different at 5% level according to Duncan.

seasons. Irrigating plants at 1, 2 or 3 weeks intervals gave rise to greater number of leaves compared to the 4 weeks one in the first season. In the second one, the highest records in this concern were induced by watering at 1 or 2 weeks intervals, while the lowest number of leaves belonged to plants watered at 4 weeks interval.

The effect of treatments on plant height was significant in both seasons. The highest number of leaves was obtained when moringa extract, K_2O_3Si or ascorbic acid were applied, in addition to applying salicylic acid in the second season only. The lowest value in the same regard belonged to the untreated control plants.

The effect of the interaction between irrigation intervals and treatments was significant in both seasons. The highest number of leaves was noticed on plants irrigated at 2 weeks interval and treated with moringa extract, plants treated with ascorbic acid and irrigated at 2 or 3 weeks interval in the first season or at 1 week interval in the second one, in addition to plants irrigated at 1 or 2 weeks interval and treated with moringa extract or K_2O_3Si in the first season only. The lowest number of leaves was observed on the untreated control plants watered at either 1 or 3 weeks intervals in the first and second seasons.

b. Leaf length (cm), Table (2):

The effect of irrigation intervals on leaf length was significant in the second season only. However, the longest leaves were produced by plants irrigated at 2 weeks interval, in addition to those watered at 1 or 3 weeks interval in the second season only. The shortest leaves were a result of watering at 3 or 4 weeks interval.

The effect of treatments on leaf length was significant in both seasons. The longest leaves were noticed on plants treated with ascorbic acid, in addition to those treated with salicylic acid in the first season only. The shortest leaves belonged to the untreated control plants.

The effect of the interaction between irrigation intervals and treatments on leaf length was significant in both seasons. Irrigating plants at 2 weeks interval and treating them with ascorbic acid gave rise to the longest leaves, in addition to those watered at 3 weeks interval and treated with ascorbic acid in the second season only. The untreated control plants watered at 4 weeks interval had the shortest leaves, in addition to those watered at 3 weeks interval under the same treatment in the first season only.

c. Leaf width (cm), Table (2):

The effect of irrigation intervals on leaf width was significant in both seasons. Watering plants at 1 or 2 weeks interval induced the widest leaves in addition to irrigating at 3 weeks interval in the second only. The narrowest leaves were a result of irrigating at 4 weeks interval in addition to watering at 3 weeks interval in the first season only.

The effect of treatments on leaf width was significant in both seasons. The widest leaves belonged to plants treated with moringa extract, K_2O_3Si and ascorbic acid in addition to plants treated with salicylic acid in the first season only. The narrowest leaves were those of the untreated control plants.

The effect of the interaction between irrigation intervals and treatments on leaf length was significant in both seasons. The highest values in this concern were a result of irrigating at 2 weeks intervals and treating with either K_2O_3Si or salicylic acid in the first season; or treated with ascorbic acid and irrigated at 1 or 2 weeks intervals in the second one. The lowest records were a result of irrigating the untreated control plants at 4 weeks interval.

d. Leaves fresh weight (g), Table (2):

The effect of irrigation intervals on fresh weight of leaves was significant in the second season only. However, the heaviest fresh leaves were a result of watering plants at 2 weeks interval, in addition to those irrigated at 1 week interval in the second season. The lightest fresh leaves resulted

when plants were irrigated at 4 weeks interval.

The effect of treatments on fresh weight of leaves was significant in both seasons. The highest values of this characteristic were induced when ascorbic acid was applied, in addition to using moringa extract in the second season. Untreated control plants had the lightest fresh weight of leaves.

The effect of the interaction between irrigation intervals and treatments on fresh weight of leaves was significant in both seasons. The heaviest fresh leaves were a function of combining between irrigation at 2 weeks interval and the ascorbic acid treatment, in addition to applying the aforementioned treatment and watering at 3 or 1 weeks interval in the first and second seasons. The lightest fresh leaves were noticed when the untreated control plants were irrigated at 4 weeks interval, in addition to watering the untreated control plants at 3 weeks interval in the first season or watering the K₂O₃Si-treated plants at 4 weeks interval in the second season.

e. Leaves dry weight (g):

The effect of irrigation intervals on stem dry weight was significant in both seasons. Watering plants at 1 or 2 weeks interval gave rise to heavier dry leaves compared to watering at 3 or 4 weeks interval.

The effect of treatments on stem dry weight was significant in both seasons. Using salicylic acid or ascorbic acid in the first season; and moringa extract or ascorbic acid in the second season resulted in higher values of dry weight of leaves compared to results obtained from the untreated control plants.

The effect of the interaction between irrigation intervals and treatments on stem dry weight was significant in both seasons. The heaviest dry leaves belonged to plants watered at 2 weeks interval and treated with either salicylic acid in the first season or with ascorbic acid in the second season. The lowest results were obtained from the untreated control plants watered at 3 or 4

weeks interval in the first season or at 4 weeks interval in the second one.

3. Effect of irrigation intervals, treatments and their interaction on flower characters (Table, 3):

a. Number of flower clusters:

The effect of irrigation intervals on number of flower clusters was significant in both seasons. The largest number in this question was a result of watering plants at 2 or 3 weeks intervals, in addition to plants watered at 1 week interval in the first season only.

The effect of treatments on number of flower clusters was significant in both seasons. The highest number of flower clusters was induced when moringa extract or K₂O₃Si were applied, in addition to plants treated with salicylic acid in the second season only. The lowest values in this regard resulted when ascorbic acid was used. The untreated control plants failed to flower at all.

The effect of the interaction between irrigation intervals and treatments on number of flower clusters was significant in both seasons. In the first season, plants watered at 1 week interval and treated with moringa extract and those watered at 3 weeks interval and treated with K₂O₃Si gave rise to the highest number of flower clusters in the two season. In the second one, plants watered at 2 weeks interval and treated with moringa extract or those watered at 3 weeks interval and treated with salicylic acid induced the highest records. The lowest number of flower clusters resulted when ascorbic acid was applied to plants irrigated at 2, 3 or 4 weeks interval in the first season; or irrigated at 1 or 2 weeks interval in the second season, in addition to those treated with salicylic acid and irrigated at either 4 weeks interval in the first season or 1 week interval in the second one. All untreated control plants in both seasons, in addition to plants watered at 4 weeks interval and treated with moringa extract or K₂O₃Si in the first season; or with

Table 3. Effect of irrigation intervals, bio and chemical treatments and their interaction on flower characters of *Euphorbia milii* var. *longifolia*.

Treat.	First season					Second season				
	Irrigation intervals (weeks)					Irrigation intervals (weeks)				
	1	2	3	4	Mean	1	2	3	4	Mean
Number of flowering clusters										
Control	0.00 g	0.00 g	0.00 g	0.00 g	0.00 C	0.00 f	0.00 f	0.00 f	0.00 f	0.00 C
Moringa	2.33 c-f	4.00 b-d	5.00 ab	0.00 g	2.83 A	3.00 b-f	7.00 a	2.33 b-f	0.67 ef	3.25 A
K ₂ O ₃ Si	6.33 a	4.33 a-c	3.33 b-e	0.00 g	3.50 A	3.33 b-e	4.33 a-d	4.67 a-c	1.67 c-f	3.50 A
Salicylic	1.67 e-g	3.00 b-e	1.67 e-g	0.33 fg	1.67 B	0.33 ef	2.33 b-f	5.33 ab	0.00 f	2.00 AB
Ascorbic	2.00 d-g	0.67 fg	0.67 fg	0.33 fg	0.92 BC	0.33 ef	1.00 ef	1.33 d-f	0.00 f	0.67 BC
Mean	2.47 A [\]	2.40 A [\]	2.13 A [\]	0.13 B [\]		1.40 BC [\]	2.93 A [\]	2.73 AB [\]	0.47 C [\]	
Number of flowers										
Control	0.00 e	0.00 e	0.00 e	0.00 e	0.00 C	0.00 e	0.00 e	0.00 e	0.00 e	0.00 C
Moringa	12.00 ab	15.67 a	12.33 ab	0.00 e	10.00 A	7.33 b-e	23.67 a	7.00 b-e	1.33 e	9.83 A
K ₂ O ₃ Si	15.33 a	15.67 a	7.67 bc	0.00 e	9.67 A	4.67 de	15.00 b	10.33 b-d	3.00 de	8.25 AB
Salicylic	2.67 de	7.00 cd	4.67 c-e	0.67 e	3.75 B	0.67 e	6.67 c-e	13.67 bc	0.00 e	5.25 B
Ascorbic	4.00 ce	0.67 e	1.00 e	0.67 e	1.58 BC	0.67 e	3.00 e	1.00 e	0.00 e	1.17 C
Mean	6.80 AB [\]	7.80 A [\]	5.13 B [\]	0.27 C [\]		2.67 B [\]	9.67 A [\]	6.40 A [\]	0.87 B [\]	
Flower diameter (cm)										
Control	0.00 d	0.00 d	0.00 d	0.00 d	0.00 C	0.00 e	0.00 e	0.00 e	0.00 e	0.00 C
Moringa	4.00 a	4.23 a	3.97 a	0.00 d	3.05 A	4.30 a	4.27 a	4.33 a	1.27 de	3.54 A
K ₂ O ₃ Si	4.17 a	4.07 a	3.00 a-c	0.00 d	2.81 A	2.50 a-d	3.87 ab	3.77 a-c	1.00 de	2.78 A
Salicylic	2.87 a-c	3.73 ab	2.20 a-d	1.17 cd	2.49 A	1.13 de	2.23 b-d	3.53 a-c	0.00 e	1.73 B
Ascorbic	1.23 cd	1.50 b-d	1.07 cd	1.03 cd	1.21 B	1.30 de	2.87 a-d	1.90 cd	0.00 e	1.52 B
Mean	2.45 A [\]	2.71 A [\]	2.05 A [\]	0.44 B [\]		1.85 B [\]	2.65 AB [\]	2.71 A [\]	0.45 C [\]	
Flowers fresh weight (g)										
Control	0.00 e	0.00 e	0.00 e	0.00 e	0.00 C	0.00 e	0.00 e	0.00 e	0.00 e	0.00 D
Moringa	6.39 bc	10.90 a	8.90 ab	0.00 e	6.55 A	6.57 b-e	17.98 a	8.80 b-d	6.62 b-e	9.99 A
K ₂ O ₃ Si	8.39 ab	10.05 a	4.80 cd	0.00 e	5.81 A	3.42 c-e	10.86 b	5.64 b-e	1.78 de	5.43 B
Salicylic	2.68 de	6.05 bc	1.59 de	0.35 e	2.67 B	0.68 e	4.91 b-e	9.00 bc	0.00 e	3.65 BC
Ascorbic	3.32 c-e	0.89 e	0.89 e	0.09 e	1.30 BC	0.84 e	1.82 de	1.81 de	0.00 e	1.12 CD
Mean	4.16 AB [\]	5.58 A [\]	3.24 B [\]	0.09 C [\]		2.30 BC [\]	7.12 A [\]	5.05 AB [\]	1.68 C [\]	
Flowers dry weight (g)										
Control	0.00 e	0.00 e	0.00 e	0.00 e	0.00 C	0.00 g	0.00 g	0.00 g	0.00 g	0.00 C
Moringa	0.78 b-e	1.84 a	1.00 b	0.00 e	0.91 A	0.70 de	1.58 a	0.79 b-d	0.09 fg	0.79 A
K ₂ O ₃ Si	1.10 ab	0.91 bc	0.64 b-e	0.00 e	0.66 A	0.43 d-g	1.22 ab	0.76 cd	0.29 e-g	0.68 A
Salicylic	0.34 b-e	0.29 b-e	0.50 b-e	0.86 b-d	0.50 AB	0.02 g	0.52 d-f	1.18 a-c	0.00 g	0.43 B
Ascorbic	0.34 b-e	0.12 c-e	0.01 e	0.05 ed	0.13 BC	0.15 fg	0.39 d-g	0.31 e-g	0.00 g	0.21 BC
Mean	0.51 AB [\]	0.63 A [\]	0.43 AB [\]	0.18 B [\]		0.26 B [\]	0.74 A [\]	0.61 A [\]	0.08 B [\]	

Means with the same letter are not significantly different at 5% level according to Duncan.

salicylic acid or ascorbic acid in the second season, failed to flower at all.

b. Number of flowers:

The effect of irrigation intervals on number of flowers was significant in both seasons. The highest number in this regard belonged to plants watered at 2 weeks intervals in addition to plants irrigated at 1 week interval in the first season or at 3 weeks intervals in the second one. The lowest number of flowers was a result of watering at 4 weeks intervals in addition to plants irrigated at 1 week in the second season.

The effect of treatments on number of flowers was significant in both seasons. The highest values in this concern belonged to plants treated with moringa extract or K_2O_3Si . The lowest number of flowers resulted when ascorbic acid was used. The untreated control plants failed to flower at all.

The effect of the interaction between irrigation intervals and treatments on number of flowers was significant in both seasons. The largest number of flowers was induced when plants irrigated at 2 weeks interval and were treated with moringa extract, in addition to plants watered at 1 week interval and treated with either moringa extract or K_2O_3Si , watered at 2 weeks interval and treated with K_2O_3Si , or watered at 3 weeks interval and treated with moringa extract in the first season only. The lowest number of flowers belonged to plants treated with ascorbic acid and watered at 2 or 3 weeks intervals, in addition to plants watered at 4 weeks intervals and treated with either salicylic acid or ascorbic acid in the first season or watered at 1 week interval and treated with either salicylic acid or ascorbic acid in the second one, besides those watered at 4 weeks intervals and treated with moringa extract in the second season.

All untreated control plants in both seasons, in addition to plants watered at 4 weeks interval and treated with moringa extract or K_2O_3Si in the first season; or with

salicylic acid or ascorbic acid in the second season, failed to flower at all.

c. Flower diameter (cm):

The effect of irrigation intervals on flower diameter was significant in both seasons. The widest flowers resulted when plants were watered at 2 or 3 weeks intervals, in addition to plants irrigated at 1 week interval in the first season.

The effect of treatments on flower diameter was significant in both seasons. The highest records in this regard were induced when moringa or K_2O_3Si were applied, in addition to using salicylic acid in the first season. The lowest values of flower diameter resulted when ascorbic acid was used, in addition to using salicylic acid in the second season only. Untreated control plants did not flower at all.

The effect of the interaction between irrigation intervals and treatments on flower diameter was significant in both seasons. The widest flowers were a result of applying moringa extract and irrigating plants at 1, 2 or 3 weeks intervals, in addition to using K_2O_3Si and irrigating plants at 1 or 2 weeks intervals in the first season; or at 2 weeks interval in the second season; besides using salicylic acid and irrigating plants at 2 weeks interval in the first season only. The lowest records of flower diameter were noticed in plants treated with salicylic or ascorbic acids and watered at either 4 weeks interval in the first season; or at 1 week interval in the second season; in addition to plants treated with ascorbic acids and watered at either 1 or 3 weeks interval in the first season; or watered at 4 weeks interval and treated with either moringa extract or K_2O_3Si in the second season.

All untreated control plants in both seasons, in addition to plants watered at 4 weeks interval and treated with moringa extract or K_2O_3Si in the first season; or with salicylic acid or ascorbic acid in the second season, failed to flower at all.

d. Flowers fresh weight (g):

The effect of irrigation intervals on fresh weight of flowers was significant in both seasons. Irrigating plants at 2 weeks interval induced the heaviest fresh flowers, in addition to plants watered at 1 or 3 weeks interval. The lightest fresh flowers resulted when plants were watered at 4 weeks interval.

The effect of treatments on fresh weight of leaves was significant in both seasons. Applying moringa extract gave rise to the heaviest fresh flowers, in addition to plants treated with K_2O_3Si in the first season. Using ascorbic acid resulted in the lightest fresh flowers. Untreated control plants did not flower at all.

The effect of the interaction between irrigation intervals and treatments on fresh weight of flowers was significant in both seasons. The highest records in this question were obtained when plants treated with moringa extract were watered at 2 or 3 weeks interval in the first season, or at 2 weeks interval in the second one; in addition to plants treated with K_2O_3Si were watered at 1 or 2 weeks interval in the first season.

The lowest values of fresh weight of flowers were noticed on plants treated with salicylic or ascorbic acids and watered at either 4 weeks interval

All untreated control plants in both seasons, in addition to plants watered at 4 weeks interval and treated with moringa extract or K_2O_3Si in the first season; or with salicylic acid or ascorbic acid in the second season, failed to flower at all.

e. Flowers dry weight (g):

The effect of irrigation intervals on dry weight of flowers was significant in both seasons. Higher values of this trait were obtained when plants were irrigated at 1, 2 or 3 weeks interval in the first season and at 2 or 3 weeks interval in the second season; compared to plants watered at 4 weeks interval and those watered at 1 week interval in the second season.

The effect of treatments on dry weight of flowers was significant in both seasons. Using moringa extract and K_2O_3Si resulted in the highest records of this character; in addition to using salicylic acid in the first season. Ascorbic acid induced the lowest values in the same question. The untreated control plants did not flower at all.

The effect of the interaction between irrigation intervals and treatments on stem dry weight was significant in both seasons. The highest dry weight of flowers was a result of watering plants at 2 weeks interval and treating them with moringa extract; in addition to treating plants with K_2O_3Si and watering at either 1 week interval in the first season or at 2 weeks interval in the second one. The lowest values of this trait were induced when plants were watered at 3 weeks interval combined with ascorbic acid in the first season or at 1 week interval combined with salicylic acid in the second season.

All untreated control plants in both seasons, in addition to plants watered at 4 weeks interval and treated with moringa extract or K_2O_3Si in the first season; or with salicylic acid or ascorbic acid in the second season, failed to flower at all.

4. Effect of irrigation intervals, treatments and their interaction on root characters (Table, 4):

a. Root length (cm):

The effect of irrigation intervals on root length was significant in the first season only. Irrespective of this observation, it could be noticed that irrigating plants at 1, 2 or 3 weeks interval gave rise to longer roots, compared to watering at 4 weeks.

The effect of treatments on root length was significant in both seasons. Using moringa extract, K_2O_3Si , salicylic acid or ascorbic acid resulted in longer roots, compared to roots of the untreated control plants.

The effect of the interaction between irrigation intervals and treatments on root

Table 4. Effect of irrigation intervals, bio and chemical treatments and their interaction on root characters of *Euphorbia milii* var. *longifolia*.

Treat.	First season					Second season				
	Irrigation intervals (weeks)				Mean	Irrigation intervals (weeks)				Mean
1	2	3	4	1		2	3	4		
Root length (cm)										
Control	33.60 cd	40.30 b-d	38.70 b-d	29.27 d	35.47 B	28.03 d	44.50 ab	40.23 a-d	29.93 cd	35.68 B
Moringa	57.17 a	47.33 a-c	43.00 a-d	41.33 a-d	47.21 A	50.17 a	39.27 a-d	39.60 a-d	34.43 b-d	40.87 AB
K ₂ O ₃ Si	47.63 a-c	52.17 ab	47.50 a-c	40.67 b-d	46.99 A	44.50 ab	43.50 a-c	42.83 a-c	42.50 a-c	43.33 A
Salicylic	50.50 ab	45.07 a-d	43.33 a-d	31.67 cd	42.64 AB	48.17 ab	41.50 a-d	40.50 a-d	39.70 a-d	42.47 AB
Ascorbic	41.17 a-d	46.83 a-c	47.40 a-c	46.47 a-c	45.47 A	36.50 a-d	48.55 ab	45.77 ab	40.27 a-d	42.77 AB
Mean	46.01 A [\]	46.34 A [\]	43.99	37.88 B [\]		41.47 A [\]	43.46 A [\]	41.79 A [\]	37.37 A [\]	
Roots fresh weight (g)										
Control	4.93 g	6.19 fg	5.76 g	5.43 g	5.58 C	4.88 d	4.57 d	4.15 d	2.58 d	4.05 C
Moringa	18.44 a	15.65 ab	13.37 a-d	10.11 c-g	14.39 A	18.00 a	16.52 a	13.88 ab	13.22 ab	15.41 A
K ₂ O ₃ Si	11.55 b-f	13.59 a-d	14.54 a-c	5.91 g	11.40 B	15.26 a	17.00 a	18.05 a	13.67 ab	16.00 A
Salicylic	15.09 a-c	12.30 b-d	11.94 b-e	6.74 e-g	11.52 B	15.09 a	13.60 ab	13.31 ab	6.26 cd	12.07 B
Ascorbic	12.07 b-e	15.26 a-c	12.90 bd	8.74 d-g	12.24 AB	11.82 a-c	13.77 ab	12.18 a-c	8.78 b-d	11.64 B
Mean	12.42 A [\]	12.60 A [\]	11.70 A [\]	7.39 B [\]		13.01 A [\]	13.09 A [\]	12.31 A [\]	8.90 B [\]	
Roots dry weight (g)										
Control	0.91 f	1.17 f	1.38 f	1.11 f	1.14 C	0.78 h	0.96 h	0.82 h	0.79 h	0.84 C
Moringa	3.29 b	3.19 bc	2.98 bc	2.44 b-e	2.97 A	3.34 a-c	3.54 ab	3.93 a	2.67 b-f	3.37 A
K ₂ O ₃ Si	2.50 b-d	3.02 bc	2.34 c-e	1.52 ef	2.35 B	3.12 a-e	3.25 a-d	2.17 e-g	1.42 gh	2.49 B
Salicylic	4.35 a	2.53 b-d	2.46 b-d	1.34 f	2.67 AB	3.05 a-e	3.25 a-d	2.83 b-e	1.09 h	2.56 B
Ascorbic	2.56 bc	3.09 bc	2.45 b-e	1.61 d-f	2.43 B	2.46 c-g	2.70 b-e	2.28 d-g	1.63 f-h	2.27 B
Mean	2.72 A [\]	2.60 A [\]	2.32 A [\]	1.60 B [\]		2.55 A [\]	2.74 A [\]	2.41 A [\]	1.52 B [\]	

Means with the same letter are not significantly different at 5% level according to Duncan.

length was significant in both seasons. The highest values in this concern occurred when plants watered at 1 week interval were treated with either moringa extract or salicylic acid, in addition to those watered at 2 weeks interval and treated with K₂O₃Si in the first season; and when plants watered at 1 week interval were treated with moringa extract, K₂O₃Si or salicylic acid, in addition to those watered at 2 weeks interval and were lift untreated or treated with ascorbic acid, together with plants watered at 3 weeks interval and treated with ascorbic acid. The shortest roots were produced by the untreated control plants watered at either 4 or 1 week intervals.

b. Roots fresh weight (g):

The effect of irrigation intervals on root fresh weight was significant in both seasons. Plants watered at 1, 2 and 3 weeks interval

got heavier root fresh weight than those watered at 4 weeks interval.

The effect of treatments on root fresh weight was significant in both seasons. Applying moringa extract resulted in the heaviest fresh roots, in addition to using ascorbic acid in the first season or K₂O₃Si in the second one. The lowest records in this concern belonged to the untreated control plants.

The effect of the interaction between irrigation intervals and treatments on root fresh weight was significant in both seasons. Treating plants with moringa extract and watering them at 1 week interval gave rise to the highest values of root fresh weight, in addition to plants having the same treatment but watered at 2 weeks interval in the second season. Plants in the second season treated with K₂O₃Si and watered at 1, 2 or 3 weeks interval besides those treated with salicylic

acid and irrigated at 1 week interval shared also in the first position in this regard. The lowest values of root fresh weight were obtained by the untreated control plants watered at 1, 3 or 4 weeks interval in the first season, or at 1, 2, 3 or 4 weeks interval in the second one.

c. Roots dry weight (g):

The effect of irrigation intervals on root dry weight was significant in both seasons. Watering plants at 1, 2 or 3 weeks interval resulted in heavier dry roots compared to watering at 4 weeks interval.

The effect of treatments on root dry weight was significant in both seasons. Using moringa extract resulted in the heaviest dry roots, in addition to using salicylic acid in the first season. The lightest root dry weight belonged to the untreated control plants.

The effect of the interaction between irrigation intervals and treatments on root dry weight was significant in both seasons. Applying salicylic acid on plants watered at 1 week interval gave rise to the highest value of root dry weight in the first season, while in the second one this superiority was attributed to using moringa extract on plants watered at 2 or 3 weeks interval. The lowest records in this concern were obtained by the untreated control plants whatever the watering regime was at 1, 2, 3 or 4 weeks interval, in addition to plants watered at 4 weeks interval and treated with salicylic acid.

5. Effect of irrigation intervals, treatments and their interaction on mineral contents (Table, 5):

a. N (%):

Watering plants at 2 or 3 weeks interval induced the highest N%, while watering at 1 week interval resulted in the lowest percentage of N.

Applying K_2O_3Si gave rise to the highest value of N%. On the other hand, the untreated control plants had the lowest record in the same question.

Plants watered at 2 weeks interval and treated with K_2O_3Si obtained the highest position concerning N%, while the untreated control plants watered at 1 week interval occupied the lowest rank of the same character.

b. P (%):

The highest percentage of P was detected in plants watered at 2 weeks interval, while the lowest was obtained when plants were irrigated every 4 weeks.

Treating plants with K_2O_3Si induced the highest value of P%, while ascorbic acid was the cause of getting the lowest one.

Plants watered at 2 weeks interval and treated with moringa extract obtained the highest P%, while those treated with ascorbic acid and watered at either 1 or 4 weeks interval had the lowest record in the same regard.

c. K (%):

The highest K% was detected in plants watered at 2 weeks interval, while the lowest was obtained when plants were irrigated at 4 weeks.

Treating plants with moringa extract induced the highest value of K%, while ascorbic acid induced the lowest one.

Plants watered at 2 weeks interval and treated with moringa extract gave the highest K%, while those treated with salicylic acid and watered at 1 week interval had the lowest record in the same concern.

6. Effect of irrigation intervals, treatments and their interaction on carbohydrates and pigment contents (Table, 6):

a. Total carbohydrate (%):

The highest total carbohydrates% was detected in plants watered at 3 weeks interval, while the lowest one was observed when plants were irrigated at 1 week.

Plants treated with moringa extract had the highest value of total carbohydrate%, while ascorbic acid induced the lowest one.

Table 5. Effect of irrigation intervals, bio and chemical treatments and their interaction on mineral contents of *Euphorbia milii* var. *longifolia*.

Treat.	Irrigation intervals (weeks)				Mean
	1	2	3	4	
			N (%)		
Control	0.66	1.65	1.76	1.76	1.46
Moringa	1.32	2.43	2.43	2.21	2.10
K ₂ O ₃ Si	2.21	2.87	2.65	1.32	2.26
Salicylic	1.32	2.21	2.21	1.10	1.71
Ascorbic	1.76	2.10	2.21	2.21	2.07
Mean	1.45	2.25	2.25	1.72	
			P (%)		
Control	0.44	0.52	0.25	0.24	0.36
Moringa	0.32	0.65	0.38	0.33	0.42
K ₂ O ₃ Si	0.36	0.47	0.46	0.44	0.43
Salicylic	0.43	0.43	0.30	0.25	0.35
Ascorbic	0.22	0.54	0.24	0.22	0.31
Mean	0.35	0.52	0.33	0.30	
			K (%)		
Control	1.66	1.86	1.95	1.72	1.80
Moringa	1.75	2.01	1.89	1.86	1.88
K ₂ O ₃ Si	2.04	1.95	1.72	1.52	1.81
Salicylic	1.46	1.86	1.86	1.81	1.75
Ascorbic	1.75	1.72	1.69	1.55	1.68
Mean	1.73	1.88	1.82	1.69	

Plants watered at 3 weeks interval and treated with ascorbic acid had the highest total carbohydrate%, while those watered at 1 week interval and treated with salicylic acid besides the untreated control plants had the lowest record in the same regard.

b. Total chlorophyll content (mg/g f.w.):

Watering plants at 2 weeks interval induced the highest total chlorophyll content, while watering at 4 weeks interval resulted in the lowest content in the same regard.

Applying ascorbic acid gave rise to the highest value of total chlorophyll content. On the other hand, plants treated with moringa extract had the lowest record in the same question.

Plants watered at 1 week interval and treated with ascorbic acid, besides those watered at 2 weeks interval and treated with either moringa extract or ascorbic acid occupied the highest position concerning

total chlorophyll content, while those treated with moringa extract and watered at either 3 or 4 weeks interval occupied the lowest rank of the same character.

c. Carotenoides content (mg/g f.w.):

Watering plants at 2 weeks interval induced the highest content of carotenoides, while watering at 4 weeks interval gave rise to the lowest content in the same regard.

Applying ascorbic acid gave rise to the highest value of carotenoids content. On the other hand, plants treated with moringa extract had the lowest record in the same concern.

Plants watered at 2 weeks interval and treated with ascorbic acid had the highest rank concerning carotenoids content, while those treated with moringa extract and watered at either 3 or 4 weeks interval occupied the lowest position of the same character.

Table 6. Effect of irrigation intervals, bio and chemical treatments and their interaction on carbohydrates and pigments content of *Euphorbia milii* var. *longifolia*.

Treat.	Irrigation intervals (weeks)				Mean
	1	2	3	4	
Total carbohydrates (%)					
Control	7.36	11.33	25.80	15.19	14.92
Moringa	13.77	12.59	11.92	8.30	11.65
K ₂ O ₃ Si	9.75	10.21	12.93	20.38	13.32
Salicylic	7.17	8.79	23.36	18.40	14.43
Ascorbic	13.00	31.14	30.61	18.58	23.33
Mean	10.21	14.81	20.92	16.17	
Total chlorophylls (mg/g f.w.)					
Control	0.92	1.15	1.03	0.33	0.86
Moringa	1.26	1.53	0.25	0.23	0.82
K ₂ O ₃ Si	0.67	0.79	0.94	0.94	0.84
Salicylic	0.84	0.84	1.46	1.18	1.08
Ascorbic	1.54	1.52	1.25	0.88	1.30
Mean	1.05	1.17	0.99	0.71	
Carotenoids (mg/g f.w.)					
Control	61.26	69.63	64.82	23.00	54.68
Moringa	64.04	72.65	18.43	16.31	42.86
K ₂ O ₃ Si	47.87	51.00	60.82	64.03	55.93
Salicylic	57.38	58.61	76.76	83.31	69.02
Ascorbic	80.59	87.17	67.94	61.21	74.23
Mean	62.23	67.81	57.75	49.57	

DISCUSSION

Our findings are in accordance with those of a lot of authors in most cases in different aspects of this work, with few exceptions that might be on the contrary.

For irrigation intervals, a lot of conflicting arguments could be found in the literature dealing with irrigation. Some researchers claimed that higher levels of irrigation are in favor of plant height. Dickey *et al.* (1963) declared that 'Formosa' azalea plants watered every 3 and 6 days were larger than those watered every day. There was little difference in growth of *Viburnum suspensum* plants watered every 1 or 3 days, and both produced larger plants than ones watered every 6 days. As watering frequency decreased from every day to every 3 and 6 days, N increased, Ca decreased and P, K and Mg showed no change in the leaf tissue. Hussein and Donald (1974), Mustafa and

Magid (1982) and Amin, (1988) reported that plant height, number of leaves per plant, leaf area, fresh and dry weight of *Sorghum bicolor* increased with decreasing irrigation interval. Kabbashi, (1991) working on the same plant mentioned that shorter irrigation intervals (10, 15 days) resulted in higher yields than longer (20 days) irrigation intervals. Musa (2003) stated that watering interval had significant effect on plant height and leaf area of *Sorghum bicolor*. Frequent irrigation interval (7 days) improved growth attributes and dry matter production. Khan *et al.* (2005) observed that 5 days irrigation interval was better compared to other intervals in relation to plant growth. The maximum plant height and number of leaves/plant were significantly better in 5 days irrigation intervals than 10, 15 and 20 days intervals in two onion varieties. Ismail *et al.* Ozawa (2009) studied the effect of irrigation interval (1, 3 and 5 day) on Chile

pepper. They indicated that increasing the water supply caused increases in the root biomass. The 1-day irrigation interval produced the highest root biomass, while the 5-day resulted in the least root biomass and caused a reduction in leaf growth. El-Naim *et al.* (2010) found that frequent irrigation intervals (7 days) improved vegetative growth, i.e. plant height, stem diameter, number of leaves per plant, leaf area and shoot dry weight of sunflower.

Ademilua (2013) stated that *Acalypha wilkesiana* plants watered daily had higher plant height, larger leaf areas, fresh weight and dry weights than those watered every three days. El-Mekawy (2013) on *Achillea santolina* showed that irrigation every 7 days increased number of branches/plant, plant height, fresh and dry weight of herb/plant, fresh and dry weight of roots/plant compared to irrigation every 14 and 21 days.

Adeoye *et al.* (2014) showed that irrigation interval has little effect on stem height and leaf number of bell pepper (*Capsicum annuum*). The tallest plant was observed in the 3 days irrigation interval, while the control un-irrigated plot has the least height. Daily irrigation interval shows the maximum leaf number and control plot recorded the least leaf number. Leaf area was highest in plot with 6 days irrigation interval and minimum leaf area was recorded in the control plot. Bostan *et al.* (2014) observed that leaf length, leaf width and number of leaves/plant were maximum at irrigation interval of 10 days compared to 5, 15 and 20 days intervals. Mohamed *et al.* (2014) investigated the influence of irrigation intervals (every 1, 2 or 3 weeks) on the growth of both *Curcuma aromatica* and *C. domestica* plants. They found that the long irrigation intervals significantly reduced growth parameters (plant height, number of leaves, width of the leaf). Growth parameters, as well as total carbohydrate increased when the plants irrigated every week, compared to irrigation treatments every two or three weeks. Taweesak *et al.* (2014) concluded that the increment of

irrigation frequencies can improve growth and flowering of *Chrysanthemum morifolium*.

Gerami *et al.* (2016) stated that there were significant effects of irrigation intervals on measured morphological traits of oregano (*Origanum vulgare*). Plant height, leaf area, fresh and dry herb yield declined with increasing irrigation intervals, while number of branches was not influenced. The highest values were obtained under 1 week interval and the minimum values for these traits were observed under 2 or 3 weeks interval, with no significant difference between them.

Increasing irrigation intervals means decreasing watering amount along a certain period of time. This reduction in watering had a negative result on most traits as mentioned by many researchers. Tucker and Maciarello (1994) found that water stress has negative effect on biomass in oregano (*Origanum vulgare*). Schuch (1998) reported that for chrysanthemum, reduction of irrigation from sufficient to deficient decreased its growth by 25%.

Hsiao and Xu (2000) reported that under water deficiency, growth is readily inhibited and growth of roots is favoured over that of leaves. Baeck *et al.* (2001) noticed that plant growth of *Ocimum americanum* decreased in response to water deficit. Singh-Sangwan *et al.* (2001) Supported that water supply is an important factor affecting growth and metabolic activities in plant species. Water deficit has generally negative effect on plant growth and development. However, there are reports on the positive effect of limited water supply, as far as the biosynthesis of secondary metabolites, enzyme activities and solute accumulation is concerned.

Guoxiong *et al.* (2002) mentioned that extensive root growth is an adaptive feature under drought stressed conditions. Albouchi *et al.* (2003) added that in order to increase absorption of water, plants in water deficit conditions often reduce their biomass production and contribute more biomass to roots. Hassani (2006) revealed that plant

height, number and length of axillary shoots, fresh and dry herb yield of *Dracocephalum moldavica* declined with decreasing soil water content.

Emmanuel (2014) stated that total biomass and root dry weights of *Picralima nitida*, (Apocynaceae) seedlings were lower in both water stressed and water logging conditions than well-watered conditions; but the lowest values were obtained under waterlogging. However, leaf area was higher in water-stressed conditions than well-watered conditions. He concluded that *Picralima nitida* can be raised with some satisfactory growth under some form of water stress but cannot grow well in flooding conditions.

Regarding positive effect of moringa extract, Asres (1995), Anwar and Bhangar (2003), Bennett *et al.* (2003) and Emongor (2012) claimed that moringa leaves contain proteins, minerals, vitamins, essential amino acids, glucosinolates, isothiocyanates and phenolics. Hall *et al.* (1982) on *Helianthus annuus* reported that applying moringa leaves extract stimulated plant growth. Fuglie (2000 a and b) remarked that leaf extracts of *Moringa oleifera* have been reported to accelerate growth of young plants, strengthen plants, increase leaf area duration, increase number of roots, produce more and larger fruits and generally increase yield by 20 to 35%. Andrews (2006) and Price (2007) mentioned that the active growth enhancing substances in *Moringa* leaf extract are reported to be zeatin, dihydrozeatin and isopentyladenine which are natural (endogenous) cytokinins. Price (2007) stated that extracts from fresh *Moringa* leaves could be used to produce an effective plant growth enhancer, increasing growth by 25-30% for nearly any crop. Mvumi *et al.* (2013) found that moringa extract increased growth and yield of beans in both greenhouse and field, and of maize in the field. However, the extract showed no significant effect on root dry weight or plant height of maize in the greenhouse. Bashir *et al.* (2014) noticed that moringa leaf extract

increased the growth of tomato plants significantly. Emongor (2015) showed that *Moringa* leaf extract applied to snap bean plants (*Phaseolus vulgaris*) at 20-30% increased vegetative growth, leaf chlorophyll content, and plant dry matter (shoot and root).

On the other hand this study emphasized the positive effect of ascorbic acid specially under stress. In this regard Abd El-Aziz *et al.* (2006) reported that salinity treatments on *Khaya senegalensis* have a depressing effect on various growth parameters (i.e. stem length, root length, leaves number/plant, leaf area and fresh and dry weight of all plant organs, total sugar, chlorophyll and carotenoids content as well as the percentage of N, P and K). However, all previous parameters tended to increase by applying ascorbic acid at 400 mg/l. Farahat *et al.* (2007) reported that pronounced increases in vegetative growth and chemical constituents of *Cupressus sempervirens* plants were observed by foliar application of ascorbic acid at 40 mg/l.

Mazher *et al.* (2011) showed that ascorbic acid at 200 mg/l increased all growth parameters (plant height, number of branches, number of leaves, root length as well as fresh and dry weights of all organs and also the content of the total carbohydrates, percentages of N, P and K) of *Codiaeum variegatum* plant. Khafagy *et al.* (2013) found that ascorbic acid (AsA) at 100 mg/l could partially alleviate the harmful effect of salinity stress on plant growth and biochemical constituents of hibiscus plants. Most criteria of plant growth (shoot height, number of branches, number of leaves, leaf area, root length as well as fresh and dry weights of shoots and roots) significantly increased by application of ascorbic acid. AsA increased photosynthetic pigments, total soluble sugars, N, P and K percentages.

Sardoei *et al.* (2014) showed that ascorbic acid at 20 mg/l had positive effect on number of flowers/plant of *Gazania rigens* cv. Daybreak Red Stripe. Sofy *et al.* (2016) stated that treating *Chenopodium quinoa* plants with ascorbic acid at 50 mg/l

caused significant increases in most of the growth characteristics (lengths of shoots and roots, number of branches/plant, number of leaves/plant, plant biomass, and the contents of photosynthetic pigments and soluble carbohydrates).

Also, salicylic acid (SA) has a remarkable influence on plant physiology as mentioned by some authors. Khan *et al.* (2003) and Yildirim *et al.* (2008) indicated that exogenous SA treatment stimulated root formation and increased mineral uptake by corn, soybean and cucumber plants. Abd El-Razek *et al.* (2013) indicated that foliar spray of salicylic acid at 0.04 mg/l one month before beginning of flowering stage increased flowering% and density of "Egazy Shami" olive trees.

Concerning the impact of salicylic acid on photosynthetic pigments, Gunes *et al.* (2007) attributed the positive effect of SA to enhanced CO₂ assimilation, active Fe content, chlorophyll concentration, and photosynthetic rate, which protect photosynthesis system. Kazemi *et al.* (2010) mentioned that foliar application of SA to plants significantly enhanced the chlorophyll content in young leaves. This phenomenon may be attributed to the fact that foliar application of SA decreased chlorophyll degradation caused by senescence and environmental stress. This effect on chlorophyll content might also be interpreted by the work of Kong *et al.* (2014) who indicated that SA acts as plant growth regulator that can effectively reduce the adverse effect on amylase activity, increase the activities of antioxidant enzymes, alleviate chlorosis and oxidative damage induced by Fe deficiency, as SA increased the uptake and translocation of Fe, promoted the activation of Fe in the leaves of peanut, resulting in increased chlorophyll content and improved seedling growth.

Conclusion:

The best results were obtained when watering plants at 2 weeks interval combined

with using either moringa extract or ascorbic acid.

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أثر نظام الري وبعض المعاملات على نباتات إيوفوربيا ميلياى لونجيفوليا المزهرة (تاج الاشواك)

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أجريت هذه الدراسة في مشتل قسم بحوث نباتات الزينة وتنسيق الحدائق، معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر خلال موسمي ٢٠١٦/٢٠١٥ و ٢٠١٧/٢٠١٦ لدراسة تأثير الإضافة الأرضية مع ماء الري لبعض المواد الحيوية والكيميائية (مستخلص المورينجا، سليكات البوتاسيوم، حمض الساليسيليك و حمض الأسكوربيك)

بالتفاعل مع فترات ري مختلفة (كل ١، ٢، ٣، و ٤ أسابيع) على النمو الخضري، التزهير والمحتوى الكيميائي لنباتات تاج الاشواك (*Euphorbia milii* var. *longifolia*) المنزرعة في أصص بلاستيك قطرها ٢٥ سم. هذا، ويمكن تلخيص النتائج في التالي: الري مرة واحدة كل أسبوعان كان أكثر فعالية في زيادة قيم أغلب الصفات التي تم دراستها. من ناحية أخرى أعطى كلاً من مستخلص المورينجا وحمض الأسكوربيك أعلى النتائج لمعظم الصفات التي تم دراستها. فيما يتعلق بمعاملات التفاعل بين فترات الري و مختلف المواد الحيوية والكيميائية، فإن نباتات الكنترول (الغير معاملة) لم تزهر، أيا كان نظام الري ، بالإضافة إلى النباتات التي كانت تروى مرة واحد كل ٤ أسابيع وعوملت إما بمستخلص المورينجا أو بسليكات البوتاسيوم ، طوال المدة التي إستغرقتها الدراسة. وفي نفس الوقت فقد جاءت معظم الصفات المدروسة لهذه النباتات في المرتبة الدنيا بغض النظر عن نظام الري. أحرزت النباتات التي عوملت بمستخلص المورينجا وكانت تروى مرة واحد كل أسبوع أعلى القيم لصفات قطر الزهرة، عدد الأفرع، طول الجذر والوزن الرطب للجذور. أما تلك التي كانت تروى مرة واحدة كل أسبوعين فقد نالت المرتبة العليا فيما يختص بصفات عدد الأوراق والأزهار، قطر الزهرة، الوزن الرطب والجاف للأزهار، النسبة المئوية للفوسفور والبوتاسيوم والمحتوى الكلي للكلوروفيل. المعاملة بحمض الأسكوربيك مع الري مرة واحدة كل أسبوعين تميزت بأعلى القيم لصفات إرتفاع النبات، طول الساق، الوزن الرطب للأوراق، الوزن الرطب والجاف للساق، محتوى الكلوروفيل الكلي والكاروتينويدات. في الخلاصة فإنه ينصح بري نباتات تاج الاشواك (*Euphorbia milii* var. *longifolia*) المنزرعة في أصص بلاستيك قطرها ٢٥ سم مرة كل أسبوعين بالإضافة إلى المعاملة بأي من مستخلص المورينجا أو حمض الأسكوربيك للحصول على أفضل النتائج.